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Investigation of policies, environmental impacts, consumption and fate of plastic bags

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Abstract

Shopping with plastic bags in supermarkets is an indispensable part of life for citizens in many developed countries. There are not only 10 billion plastic bags given out in the UK but also huge amounts consumed in other countries. However, this great consumption poses adverse impacts on the environment. Due to the characteristics of high-density polyethylene (HDPE) bags, bags deposited in landfill sites are not degraded naturally. Plastic bags are also photo permeable and highly transparent, making it easy for them to mimic jelly fish. Marine organisms may consider them as jellyfish for food, Moreover, seabirds may be trapped by plastic bags. The aim of this study is to investigate the impacts, fate and consumption of plastic bags and examine the feasibility of implementing a plastic bag levy in the UK. A literature review on policy indicated plastic bag charging is sufficient to reduce its consumption by changing customer behaviour. A questionnaire was designed to investigate the behaviour and environmental concern of customers, the consumption of bags, the public concern if all supermarkets imposed a charge, and the issues around implementing a charge. Interviewees were interviewed in Sainsbury's which has no plastic bag charge, and Marks and Spencer (M & S) which has introduced a plastic bag charge in Plymouth, UK. The questionnaire was designed to set up Sainsbury's as a current plastic bag consumption model, and M&S as a simulation model after charging. However, the results show no significant difference between Sainsbury's and M&S. If a charge is implemented, a minority of customers would change their behaviour and use their own bags. This indicates that if charging is introduced in the UK, plastic bag consumption may not show a significant reduction. Moreover, in experiences in other countries, if a plastic bag charge is implemented, paper, biodegradable and non-woven bags are used as plastic bag substitutes which are no more environmentally friendly than HDPE bags.

Introduction

Plastic bags are a by-product of petroleum refining. The first plastic bag was introduced as a sandwich bag in 1957 (The Plastics Industry Trade Association, 2009) and became more and more popular around the world. Nowadays, plastic shopping bags are a part of life for urbanized city and developed countries' citizens. According to DEFRA (2009), approximately 10 billion carrier bags were given away in the UK in 2008. But most of the plastic shopping bags are non-degradable - they tend to exist in the environment for a long time (Boone & Kurtz, 2010), therefore leading to adverse environmental impacts and other related social issues; for example suffocation of marine organisms due to plastic and the increasing loading of landfill. However, the reduction of plastic bag consumption may be the solution to these problems. There are successful experiences in Ireland which had introduced a charge for plastic bags in 2002 to reduce the consumption of plastic shopping bags. The aims of this study are to investigate the impacts, fate and consumption of plastic bags.

Objective

To achieve the aims of this study following the following objectives:

Environmental impact

- Assess the environmental impacts of using plastic bags in terms of energy and organism
- Compare the environmental impacts between different types of bags

Fate and Consumption

- Compare different countries' approach to the treatment of plastic bags
- Investigate the behaviour of the plastic bag consumption model in the UK.
- Examine the practice of reuse, recycling and disposal of plastic bags
- Investigate the substitutes of plastic carrier bags
- Investigate the effect of imposing plastic bag charging in the UK, by questionnaire and literature review
- Find out the reasons why customers do not always take their own bags to the supermarket.
- Estimate the outcome if the government forced all supermarkets to charge for plastic bags
- Find out the intention factors influencing customer behaviour

Literature review

There are lots of adverse environmental impacts and social issues resulting from plastic bag consumption in the UK. Although consumption has decreased from 2008, it is still at a high consumption level (Figure 1). Therefore, mitigation measures are necessary.

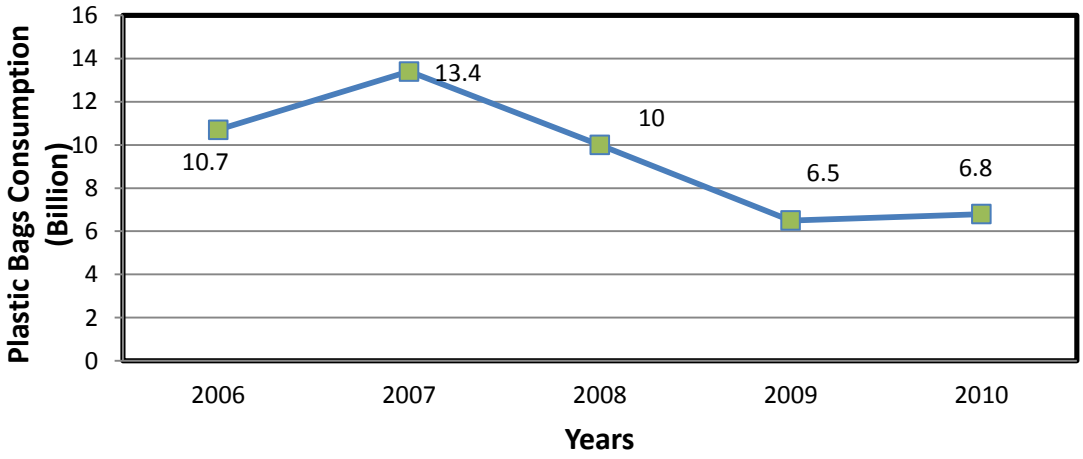

Figure 1: The consumption of plastic bags in the UK from 2006 to 2010. (DEFRA, 2009; Hickman, 2009; WRAP, 2011)

Types of bags

Types of plastic

Plastic can be mainly divided into two types; thermoplastic which is difficult to recycle, and thermosetting which is easy to recycle. The recyclable thermosetting plastic can be further categorized into different sub-types. Some environmental impact occurs due to the characteristics of plastic. For example, plastic takes up to 500-1000 years to decompose since it is an excellent chemical resistant which means high tolerance in acidic and alkaline conditions. It also resists a wide range of chemicals (Rosato, Rosato & Rosato, 2000). Furthermore, the density of HDPE (major plastic bag composition) is 0.941 g/cm^3 (Federal Emergency Management Agency, 2007), which is much lower than the density of surface sea water which is 1.015 g/cm^3 (Baronti *et al.*, 2012). If the bags are discharged to the ocean, they float on the sea surface and seafowl may be trapped in them.

The most common composition of shopping bags is high density polyethylene (HDPE). The volume and weight of a typical shopping bag is about 17.9-21.8 liters and 7.5-12.6 grams respectively, the detail of these data are shown in Appendix 1. The strength and thickness of plastic depends on the percentage of HDPE (Tough, 2007). Therefore, the greater the strength of plastic, the higher the percentage of HDPE, which in turn results in more adverse damage to the environment.

High Density Polyethylene

HDPE is the major composition of carrier bags. It is a large molecule consisting of repeating units of monomers (Lajeunesse, 2004). The molecule composing the HDPE is ethene, which is represented chemically as -[CH_2-CH_2]$_n$-, shown in Figure 2. Ethene is a by-product of naphtha refining. The naphtha is heated up to 1000^{o}C

during the process of steam cracking. This process aims to convert large hydrocarbon molecules to smaller unsaturated molecules.

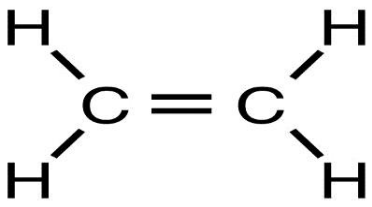

Figure 2: Chemical structure of ethene

The addition polymerization process requires a temperature of 300^{o}C and 1 atmosphere pressure conditions. Metallocene catalysts such as aluminium-based metal oxides must be added during the formation of HDPE. The paraffin or cycloparaffin will be bonded between ethylene molecules. The HDPE forms and is ready to use after cooling.

For coordination polymerization, the formation of HDPE occurs between 50-75^{o}C, the catalyst as aluminium alkyl and titanium chloride must be added as colloidal agents. The HEPE powder forms and is then ready to use. (Holden, 2000)

Biodegradable bags

The HDPE plastic bags cannot degrade naturally; therefore degradable bags have been investigated by scientists. The American Society for Testing and Materials defines 'biodegradable' as "capable of undergoing decomposition into carbon dioxide, methane, water, inorganic compounds, or biomass in which the predominant mechanism is the enzymatic action of microorganisms, that can be measured by standardized tests, in a specified period of time, reflecting available disposal condition." (ASTM, 1996).

Biodegradable bags are composed of starch, cellulose, lactic acid compounds or synthetic polyesters such as aliphatic polyesters, which are degradable hydrolytically or enzymatically by micro-organisms such as bacteria, fungi and algae. The main types of aliphatic polyesters are currently propylene terephthalate and trimethylene terephthalate (Papageorgiou, 2011).

There are significant chemical structure changes in certain conditions during the process of biodegradation by micro-organisms. The biodegradable bags will not be degraded during normal usage; they will be degraded by specific microorganisms which can be found easily in soil. After the degradation, the end product becomes more bioavailable which can be composted (Desbmukb, 2011).

Distribution and the fate of plastic bags

The fate of plastic bags, including production, distribution, destination and disposal had been investigated by the Australian government (Cain & Oke, 2008). There were 3.93 billion plastic bags given out in Australia in 2007, 81 per cent (3.17 billion) of these bags were imported from China and India which has the same high ratio as the UK (98% or an estimated 13.1 billion in 2007 (Edwards, 2006)). Over 93% of bags were distributed by supermarkets, meaning that supermarkets are the major distributor. It indicated that the most effective reduction of plastic bags could be achieved if a charge was implemented by the supermarkets. Also, the major consumers of plastic bags are households, since 92 per cent of bags are consumed by the individual. On the other hand, if customers' behaviour changed, a significant reduction in plastic bag consumption may occur. The major disposal methods of plastic bags are incineration, landfill and recycling, but due to the absence of incinerators in Australia, disposal by incineration had not been considered in this report. 16 per cent (610 million) of plastic bags are recycled in Australia which is higher than the national average (approximately 1%) (Sugii, 2008). 84% (3.3 billion) of bags were disposed of at landfill; therefore landfill is currently the major disposal method of plastic bags in Australia (Cain & Oke, 2008; Sugii, 2008).

Environmental Impact

Energy requirement

The production of plastic bags requires a large consumption of electricity; 6.151 kWh per 1000 HDPE plastic bag is required (Edwards, 2006). Normally, each family consumes 4.2 MWh per year (Pennwell Corporation, 2011). With approximately 10 billion carrier bags given away in the UK in 2008 (DEFRA, 2011), 61,510 MWh was required for plastic bag production in UK for that year. The energy required for plastic bag production each year can sufficiently provide electricity for 15,000 families.

Consumption, Reuse and Disposal

There are 4200 tonnes of solid waste generated during the process of HDPE plastic bags production in a year (Edwards, 2006). Each plastic bag can take up to 500-1000 years to decompose, and may never be broken-down in landfill (Llywodraeth Cymru, 2011).

The recycling rate of plastic carrier bags is less than 1 per cent globally (Sugii, 2008). According to the Waste and Resources Action Programme (WRAP), 75.2% of single use carrier bags are reused overall (WRAP, 2005). The major reuse of those carrier bags is use as a bin liner in the kitchen and other rooms where rubbish is placed into the bags then thrown away. The reuse rate for these purposes is 53%, 26% and 43% respectively which is shown in Table 1 (WRAP, 2005).

Table 1: The reuse of carrier bags (WRAP, 2005)

Reuse applications	Percentage of respondents that reuse single use carrier bags in each application
Use as a bin liner in kitchen	53%
Use as a bin liner in other rooms	26%
Put rubbish into it then throw it away	43%
For dog / cat / pet mess	11%
Garden refuse	1%
Reuse for supermarket shopping	8%
Reuse for other shopping	10%
To store things at home	14%
For packed lunches	8%
Carry other things in when going out	4%
Put football / Wellington boots in	1%
Give to charity shops	1%
Keep bottles / cans in for recycling	1%
Other uses	2%
Do not have a use / discard	11%

Although plastic bags are often reused, the final disposal of these will be in landfill or by incineration (Edwards, 2006). There were 10 billion carrier bags given away in the UK in 2008 (DEFRA, 2011). If all were converted to mass, that would equal 87,000 tonnes, nearly the same as the solid waste that went to landfill in Plymouth (Plymouth City Council, 2008). The loading of landfill sites would be seriously affected, and consequently decreased by a disposal of carrier bags.

Effect on organisms by direct disposal

When plastic bags are deposited in the open channel, they will discharge to the river or sea by water current. If plastic bags are present in the river or sea, the respiratory system of marine organisms such as gills may become blocked. This effect especially occurs in animals with a large configuration such as dolphins and whales (Allsopp *et al.*, 2005). In coastal cities, the suffocation of dolphins and whales caused by plastic bags is not difficult to find (Msnbc.com, 2010; Underwatertimes.com, 2006). These animals may starve to death by through the blocking of their stomachs (Richardson, 2011) resulting, in one example, with 0.7 tonnes of plastic bag found in the stomach of a whale (News24, 2011). Also, plastic bags are ingested directly by some marine organisms such as minke whale (Daily Mail, 2008). Plastic bags have a high tolerance to acidic conditions, as previously mentioned; therefore these bags cannot be digested by stomach acid and present in the gut for the whole life of an organism which ingested them.

Furthermore, plastic bags are photo permeable and highly transparent. Also, bags will open and close from the force of an ocean current, mimicking jelly fish swimming. From the point of view of some marine organisms, such as sea turtles, which depend on jellyfish as food, plastic bags will be mistaken for this food source.

There is therefore an increase in the probability of bags being ingested by marine organisms such as turtles (Marine Connection, 2011), and, as a consequence, there is a large ratio of plastic found in turtles' bodies (Fallabrino, 2011).

Also, plastic bags are invisible to seabirds. There has been a significant impact on this group which dives from the air into the water to catch fish with their sharp bills, i.e. *Sterna maxima*. These birds may be trapped by bags during this behaviour. If the birds trapped are by bags, their hunting and flying skills will be negatively affected (Amos, 2012).

Impact assessment of different bags

Plastic bags have been replaced by biodegradable, paper and non-woven bags in many countries such as Ireland, Australia and Hong Kong (Environment Australia, 2002; HKEPD, 2007). However, the environmental impacts of these bags are not lower than plastic. The details of assessment are shown in Table 2. This assessment assessed the environmental impact (such as global warming potential and toxicity in the ecosystem) of different types of bags, and was conducted by the Intergovernmental Panel on Climate Change (IPCC) and Institute of Environmental Science (CML) (Institute of Environmental Science, 2001; Solomon *et al*, 2007). The IPCC focused on the global warming potential, which is the "carbon footprint", and the CML 2 baseline focused on the ranges of impact categories. This impact assessment included the process of extraction or production of raw materials, production processes, transport, end of life and avoided products (re-processing) and recycling.

The result shows that biodegradable, paper and non-woven bags may not be more environmentally friendly than HDPE bags. Since biodegradable and paper bags can be decomposed by microorganisms, it means that the bags provide nutrients for microorganisms. Therefore a higher risk of eutrophication occurs through the process of decomposing bags (Harding *et al.*, 2007). Eutrophication is the result of the exponential growth of phytoplankton in lakes or oceans which are contaminated by a large amount of natural nutrients and substances. If eutrophication occurs in lakes or oceans, the dissolved oxygen in the water body will be decreased rapidly by an exponential growth in phytoplankton during the process of respiration. The organisms such as fish and shrimp will be suffocated because of the low dissolved oxygen level, and the food web, biodiversity and balance of nature may be eventually affected especially in lakes which are highly contaminated with nutrients (Ansari *et al*, 2011; Scholten *et al*, 2005). Also, since the bags are a nutrient source for microorganisms, they may promote the growth of particular microorganisms which will produce certain toxicants (Harding *et al.*, 2007; Kendall, 2007).

Table 2: The environmental impact of the HDPE, Biodegradable, Paper and Non-woven bags (adapted from Edwards, 2006; Solomon *et al*, 2007).

			Types of bags				
			HDPE	Biodegradable	Paper	Non-woven	
			Single	Single	Single	Single	Used
Method	**Impact category**	**Unit**	use	Use	use	use	14 times
IPCC 2007	Global warming potential	kg CO_2 eq	1.578	4.184	5.523	21.51	1.536
CML 2 baseline	Abiotic depletion	g Sb eq	16.227	15.734	26.697	274.764	19.626
	Acidification	g SO_2 eq	11.399	18.064	37.47	101.314	7.237
	Eutrophication	g PO_4--- eq	0.775	7.240	5.039	14.579	1.041
	Human toxicity	kg 1,4-DB eq	0.211	1.151	3.247	3.046	0.218
	Fresh water aquatic ecotoxicity	g 1,4-DB eq	66.880	199.955	150.204	467.717	33.408
	Marine aquatic ecotoxicity	kg 1,4-DB eq	126.475	282.754	244.657	1411.312	100.808
	Terrestrial ecotoxicity	g 1,4-DB eq	1.690	8.173	24.719	50.812	3.629
	Photochemical oxidation	g C_2H_4	0.531	1.232	1.955	5.247	0.375

Remarks: (i) The baseline of this assessment was 'single used HDPE bags',

(ii) 1,4-DB: 1,4 Dichlorobenzene is the unit of toxicity, cancer and diseases may occurred by this chemical but no direct evidence or clinical data provided in previous studies (Agency for Toxic Substances and Disease Registry, 2006).

Furthermore, although the paper bags do not white in colour, bleach such as sulphite is added during the production process (Blanc, 2007). Therefore, acidification of soil or ocean may occur (Solomon *et al*, 2007). Acidification is a consequence of decreasing pH in a water body. Shelled organisms, such as barnacles, will be seriously affected by acidification (Findlay, 2010). Also, a non-woven bag contains 30 to 50 times more plastic materials than a HDPE bag. Therefore, if a non-woven bag is reused less than 30 times, the average plastic consumption is higher than the single used bags (Legislative Council, 2011).

Policy

To achieve sustainable development, the adverse environmental impacts caused by the use and disposal of plastic shopping bags must be alleviated. International governments have developed various policy frameworks that focus on changing consumer behaviour regarding plastic bag consumption. Three core mechanisms are involved: legislation, the 'green market' and voluntary action (Ritch, Brennan & MacLeod, 2009).

These mechanisms focus on four basic resources identified by Hood (1986), which are *information*, *finance*, *coercion* and *organization*. According to Lowi (1966, 1972), the resources are associated with the mechanisms as follows and shown in Table 3:

(a)***distributive*** policies, weakly sanctioned and individually targeted;
(b)***regulatory*** policies, strongly sanctioned and individually targeted;
(c)***redistributive*** policies, strongly sanctioned and generally targeted; and
(d)***constituent*** policies, weakly sanctioned and generally targeted.

Table 3: Illustration of core mechanisms, related policy type and resources provided for changing consumer behavior from plastic bag use (based on Lowi, 1972)

Core mechanisms	Legislation	The 'Green' Market	Voluntary action
Policy resources	Coercion Organisation	Finance Information Organisation Coercion	Information Organisation
Policy type	Regulatory	Redistributive	Constituent
Policy objective	Sustainable consumption		

Voluntary action -Governmental Policy

In the UK, there has been little effort on either legislative or taxation to modify consumer behaviour around plastic bag use. Instead, voluntary action has been initiated from within the retail sector (underpinned by dialogue with the government) and community initiatives have been widely observed.

For example, Scotland withdrew the 'Environmental Levy on Plastic Bags Bill' on 24thOctober, 2006 (The Scottish Parliament, 2006). However, tangible voluntary action was initiated within a retailer group in May 2008. The Zero Waste Retailers Group was created by Environment Secretary Richard Lochead and has taken more concrete steps in changing consumer behaviour on the use of plastic bags. This group was led by the government and included the Scottish Retail Consortium and Waste Aware Scotland. The Group's remit included how best to engage with the

Government's zero-waste agenda by considering options for voluntary action in that regard (Scottish Government, 2008a).

The UK government prefers voluntary action to coercive policies such as a ban on the use of plastic bags. or a plastic bag levy, but it would take action if the voluntary initiatives among the retailers fails to achieve the UK target of reducing the overall impact of carrier bags by 25 per cent by the end of 2008 (Scottish Government, 2008b).

The main reason for that is the government takes a stance on the retailer side, stating that imposition of legislation banning plastic bag use, or taxing their use, will not find unanimous support among retailers. Instead, the UK government tends to avoid such radical measures by examining a range of consumer principles promoted by the Scottish Consumer Council (SCC). The principles include access, choice, information, redress, safety, fairness and representation (SCC, 2007; Ritch, Brennan & MacLeod, 2009).

In Australia, approximately 6.9 billion new plastic shopping bags were used in 2001 (Environment Australia, 2002). Australia adopted a voluntary approach in October 2003 called the Code of Practice for the Management of Plastic Bags. The Code was agreed between the Australian Retailers Association and the Environment Protection and Heritage Council (Australian Retailers Association, 2005) and required 90 per cent and 25 per cent participation rates for supermarkets, retail and smaller retailers respectively, and set out a 50 per cent reduction target to be achieved by the end of 2005. A recycling rate of 15 per cent (through in-store collection) was also set for the end of 2005 (Clean Up Australia, 2007).

As a consequence of the Code, major retailers reduced plastic bag use by about 41-44 per cent. And nationally, Australians reduced overall plastic bag use by about 34 per cent from 6.9 billion in 2001 down to 4.55 billion bags in 2005 (Environment Protection and Heritage Council, 2012). Also, the recycling rate increased to 14 per cent (Australian Retailers Association, 2006). The change of plastic consumption in Australia from 2001 to 2007 is shown in Appendix 2.

Legislation - ban on the use of plastic bags

Over the world, some governments and businesses have taken a coercive approach and imposed bans on the use of plastic bags through legislation. This aims to alter consumer behaviour regarding the use of plastic shopping bags (Ritch, Brennan & MacLeod, 2009).

South Africa banned plastic bags that are under 30 microns thick (typical supermarket bags are 18 microns), following its referral as the 'National flower' because of disregarded wind-blown plastic bags caught in the branches of trees and bushes (Williamson, 2003). There is no data on the effectiveness of the scheme.

Bangladesh banned all polythene bags in March 2007 because of the problem of deposited bags clogging the drainage system, and seriously worsening the floods which caused two-thirds of the country to be submerged in 1989 (BBC, 2002a), as well as the problem of the spread of water-borne diseases (Williamson, 2003). Likewise, to prevent drainage from clogging, India imposed a ban on plastic bags in Bombay (Environment Australia, 2002).

Elsewhere in Asia, Taiwan also banned the distribution of plastic bags in January 2003 (Williamson, 2003). However, the Taiwan Environment Protection

Administration retracted this in March 2006 because of evidence that the policy was ineffective (Carrier Bag Consortium, 2006).

Green market - ban on offering free plastic shopping bags

Many governments have focused on redistributive policies in plastic bag levies in order to change consumer behaviour in relation to their use. However, there is no absolute evidence to show that the plastic bag levy is a good policy for reducing use of plastic shopping bags. There have been examples of no effect, negative effect, and positive effect resulting from these policies:

No effect

Italy has imposed an indirect charge of €0.0051 on plastic shopping bags since 1988, but with no effect on consumer behaviour or plastic bag usage (Environment Australia, 2002). Denmark introduced a tax based upon weight in 1994 along with various other green taxes to encourage the use of textile shopping bags, reducing plastic bag usage and paper consumption by 66 per cent. However, the tax is not being charged to the consumer but is handled by the retailers; as a consequence, the consumer behaviour has remained unaffected. (Ritch *et al.*, 2009; Clean Up Australia, 2007)

Negative effect

Since July 2002, the Taiwan government has implemented the 'Restricted Use Policy On Plastic Shopping Bags' to reduce the overuse of plastic shopping bags. Hypermarkets, supermarkets, department stores, convenience stores, and several other kinds of stores are prohibited from offering free plastic shopping bags. Customers can only buy these at a price of NT$1-3 (about 0.03 - 0.10 U.S. dollars).

Despite the benefits brought by the policy with a reduction of up to 20,000 tons of plastic bags per year (EPA, 2002a), many criticisms arose. The Environmental Protection Administration made an incorrect assumption that people would reuse thick plastic bags more often than they would reuse thin bags, and this allowed hypermarkets and other big stores to sell only thick plastic shopping bags or non-woven bags. Also, the stores offered customers free paper bags (Lam & Chen, 2006).

With the thick plastic bags, which were 4 times thicker than the thin ones, being allowed to be bought, the policy would not be effective in eliminating the plastic trash (Lam & Chen, 2006). Jang (2003) found that, of 203 customers at a hypermarket, 12 per cent had bought thick plastic bags at the checkout.

Prior to the Hong Kong Government's introduction of a plastic bag levy in 2009, there had public consultation, education and advertisements carried out before legislation was established. These series of actions had successfully and significantly awakened public concern in environmental responsibility. The plastic bag consumption before and after the implementation of a levy was investigated by the government. As a result, plastic bag consumption decreased from 8,691 million per year in 2005 to 4,687 million per year in 2009, a 46% reduction in consumption. These data were collected from the shops which were under the regulation of the levy (HKEPD, 2009).

Although the number of plastic shopping bags distributed by registered retailers had reduced by 90 per cent in comparison with the situation before the scheme was enforced, there was a 19.8 per cent increase (from 484 in 2009 to 580 tonnes per

day in 2010) in total plastic bag disposal after the levy (Hong Kong Information Services Department, 2010). Plastic bags given out in markets to shops not under the levy regulation had not been counted by the government, hence there were differences from the reduction rate published by the government. Figure 6 shows the number of plastic bags which were disposed to landfill in Hong Kong. There was a 36% reduction in plastic bag disposal between 2005 and 2009, but an increase in 2010.

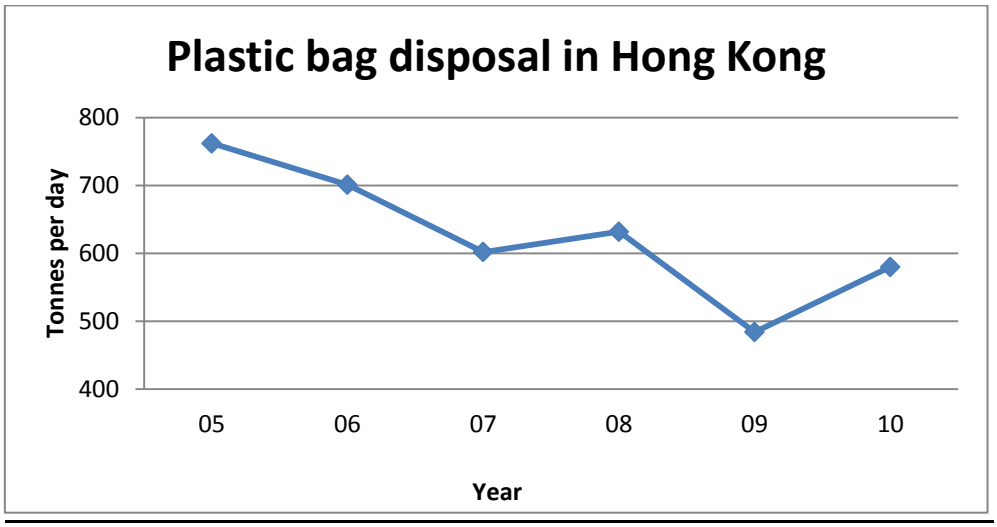

Figure 3: Plastic bags Disposal in Hong Kong from 2005 to 2009.

(Chan, 2011; Chen, 2010; Leung, 2008; Leung, 2009; Wong, 2006; Wong, 2007)

Positive effect

In contrast, the Republic of Ireland introduced a tax of €0.15 per plastic shopping bag in supermarkets, shops, service stations and all sale outlets in 2002. Prior to the implementation of the levy, the plastic bag consumption was estimated as 328 per capita per year, equal to 1200 million per year. The levy successfully changed consumer behaviour in relation to the disposal and consumption of plastic bags. The levy led to a reduction in per capita usage to 21, equal to 76 million bags consumed in the first year; in other words the consumption of plastic shopping bags was cut by 94 per cent. More encouraging is an extra €3.5 billion raised in extra revenue in its first year of implementation. (BBC, 2002b; Department of the Environment, Community and Local Government, 2007)

According to the Republic of Ireland's Minister for the Environment, Heritage and Local Government at the time, the use of plastic bags could raise national consciousness about the role each person has in waste management and sustainable development (BBC, 2002b).

Incomprehensible Policy

In Scotland, there were one billion plastic bags used in 2008. The Scottish government spent £385 million for dealing with plastic bag waste, which could have been recycled (Scottish government, 2009). According to the Scottish government, the average cost to the retailer per thousand bags was around £7.47. Therefore, the government spent £385 million for disposing plastic bags, but chose not to generate £7.47 million and protect the environment (Scottish government, 2009).

Behaviour

The behaviour of consumers determines the amount of plastic bags used and deposited. To implement a suitable policy to successfully make reductions in the overuse of plastic shopping bags, behaviour of consumers must be assessed. The six factors affecting behaviour of consumers that should be investigated are: the attitude toward the behaviour; environmental concern; and personal norm (or ACN - a mixture of the attitude, concern, and personal norm items)); self-efficacy of bringing bags to a shop or not requesting bags; response efficacy; and situational variables (Lam & Chen, 2006).

Definition of these factors

a. Environmental concern

Its meaning is different for different authors, as it has been measured in various ways (Stern, 1992). In this study, it refers to peoples' concern for the environmental problems caused by plastic shopping bag consumption (Lam & Chen, 2006).

b. Personal norm

This means a sense of obligation to take pro-environmental actions. In this study, personal norm refers to one's perceived obligation to avoid buying or requesting a plastic shopping bag during their visit

There are many arguments and evidence that personal norms may affect environmental behaviours (Stern, 2000). According to Hines *et al.* (1986), personal norm was regarded as an important independent variable in their model of responsible environmental behaviour. The main difference in their model is that personal responsibility was used rather than personal norm.

Personal norm is often considered to be a main contributing factor. For example, in six studies reviewed by Hines *et al.* (1986), people who owned a high level of responsibility for the environment were more likely to act in a pro-environment manner. In Lam and Cheng's (2003) study, environmental group members in Taiwan who were perceived as having a high personal norm were more likely to look for the environmental causes and to be ecotour interpreters, spreading the message for environment protection (Lam & Chen, 2006).

c. Attitude toward behaviour

This refers to the predictor of behavioural intention in the theory of planner behaviour. According to Hwang, Kim, & Jeng (2000) and Lam (1999), attitude toward behaviour was considered as an important predictor of environmental behaviour.

For example, in the review studies from Hineset *et al*. (1986), the attitude toward specific behaviour (for example: energy conservation, the use of unleaded oil) could determine behaviour better than general environmental attitude did (Lam & Chen, 2006).

d. Self-efficacy

This refers to a person's self-evaluation of his or her ability and resources to carry out a certain action. Self-efficacy of 'bringing' bags and self-efficacy of not requesting bags should be assessed - a construct developed by Bandura (1977). A similar construct, namely perceived behavioural control, has been incorporated in the theory of planner behaviour as a predictor of behavioural intention. As a result, self-efficacy

was found to be a good predictor of environmental behaviour (Lam, 1999; Lam & Cheng, 2003).

e. Response efficacy

This means a person's evaluation of whether his or her action can be effective in attaining certain goals or solving some problems.

According to the research in health behaviour (e.g., Block & Keller, 1998; Jayanti & Burns, 1998), response efficacy was found to be positively related to people's intentions to take preventive health actions. Environmental group members who had high response efficacy were more likely to be ecotour interpreters (Lam & Cheng, 2003).

f. Situational variables

These refer to conditions related to the goods a customer buys. Conditions include:

(a) whether the goods are easy to carry with bare hands
(b) whether the amount or volume of goods is larger than what the customer had expected,
(c) whether the goods make the customer feel embarrassed to carry around without bagging. For example, underwear and condoms
(d) whether the goods are heavy or light

According to Lam and Chen (2003), self-efficacy of bringing bags was one of the main factors that determined customers' bag-bringing behaviour, although a later study found that situational variables determined customers' bag-buying behaviour (Lam & Chen, 2006).

Customers' behaviour is controlled by behaviour intention, the intention being affected by the above factors. Figure 4 shows this relationship.

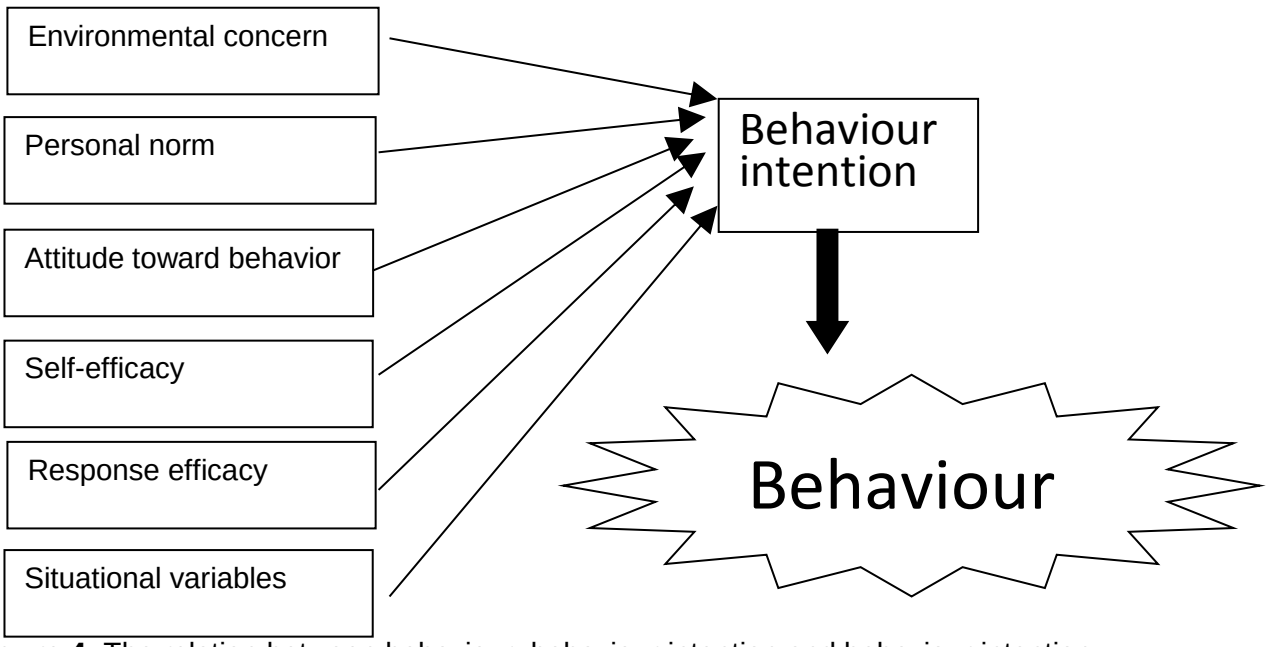

Figure 4: The relation between behaviour, behaviour intention and behaviour intention factors

Methodology

The rationale of plastic, environmental impacts caused by plastic bag consumption and disposal, policies of plastic bag consumption control, the behaviour of customers in plastic bag consumption and the theory or reasons behind these were investigated through a literature review of books, academic journals and internet references. The consumption of plastic bags, behaviour, consideration of plastic bag charges and the effects where charges are implemented were investigated by questionnaire.

Questionnaire

This study aimed to use a set of psychological and situational variables to predict customers' bag use behaviours, which included bringing their own bags and buying bags from a hypermarket.

Results showed that our model could predict both bag bringing and bag buying behaviours. Self-efficacy of bringing bags was the main variable that determined whether customers would bring their bags for shopping, whereas situational variables determined whether customers would buy bags. Implications of these results and suggestions for the policy practices are discussed.

50 questionnaires were collected from Sainsbury's and Marks & Spencer (M&S) in Plymouth, UK: the major difference between these two hypermarkets is that Sainsbury's does not charge for plastic carrier bags and M&S does. Therefore, Sainsbury's offers a current plastic bag consumption model, and M&S can be viewed as a simulation after charging. Every fifth customer that came out from the shops were asked to be an interviewee.

Questionnaire design

There were 14 questions included in the questionnaire (Table 4).

Table 4: Questionnaire design.

1. How often do you visit this branch of (Tesco, Sainsbury's, M&S)? (i) More than once per week (ii) Once per week (iii) Once per fortnight (iv) Less than once per fortnight
2. Do you bring bag(s) to this supermarket? (i) Always (ii) Frequently (iii) Sometime (iv) Never
3. How many bag(s) did you **USE** during this visit? (0) 0 (i) 1 (ii) 2 (iii) 3 (iv) 4 (v) 5 (vi) 6 (vii) More than 6
4. How many plastic bag(s) did you **GET** for this supermarket during this visit? (0) 0 (i) 1 (ii) 2 (iii) 3 (iv) 4 (v) 5 (vi) 6 (vii) More than 6
5. If you bring your own bag(s) to the supermarket, what type(s) are they? (Can be more than one option) (i) Thick renewable plastic bag (ii) Normal plastic bag

(iii) Non-woven/ cotton renewable bag (iv) Other container (such as plastic box):_____
6. Why do you not always bring your own bags? (Can be more than one option) (i) I forget to bring them. (ii) The bags will be provided by shops. (iii) I recycled my plastic bags (iv) I threw out my plastic bags at home (v) I have used all my plastic bags for other things. (vi)Bringing shopping bags to this supermarket is not convenient (vii) When I take out a used bag it makes me feel embarrassed. (viii) I had to buy more than I plan to. (ix) Others (please state):
7. Do you think it is a good idea to force all supermarkets to charge for plastic bags? (i) Yes (ii) No (iii) Don't know/ No idea.
8. If a plastic bag charge is introduced by supermarkets, what payment per bag would be acceptable for you? (i) 5p (ii) 10p (iii) 15p (iv) Other(please state):_____
9. What action will you take, if the price of levy equal to your choice at Q.8? (i) I will bring my own bags (ii) I will buy the bags from the shops.
10. How should the supermarkets spend the extra income generated by the plastic charge? (i) To add to their profits (ii) To reduce the price of goods (iii)As a foundation for environmental protection (iv) Other(please state):_____
11. Would you have any expectation of plastic bags quality after the introduction of a charge?(Can be more than one option) (i) Stronger (ii) Larger volume (iii)More long lasting (iv)More environmentally friendly (v)No expectation
12. Could you tell me your age group? (Optional to answer) (i) <18 (ii)18-24 (iii)25-34 (iv)35-49 (v)50-64 (vi)>65
13. Gender of interviewees.

(i) Male (ii)Female
14. The average loading of the bags which hold by customers. (i) 0% (No bag used) (ii) 25% (ii) 50% (iv) 75% (v) 100% (Nearly full)

Questions 13 and 14 were 'Observational Questions', which meant they were not put to responders directly; the results were recorded by the interviewer's own observation.

The six behaviour intention factors mentioned in the previous section (Lam & Chen, 2006; Lam & Cheng, 2003) and used to categorise behaviours in this study were:

1. Environmental concern
2. Personal norm
3. Attitude toward behaviour
4. Self-efficacy
5. Response efficacy
6. Situational variables

The questionnaire design was based on this theory and each question could potentially include more than one intention factor.

The assumption of this questionnaire was that 'If a customer more frequently brings their own bags to a supermarket and has a higher average loading of the bags, he or she has more environmental concern than the others'; this was also the conclusion of previous studies (Chen & Yam, 1995; Gatersleben, Steg & Vlek, 2002; West, 2012).

Question 1 collected data on how often the responder visited that supermarket: the more frequent the visit, the larger the impact occurred. The options for this question were based on previous studies which related to the behaviour of customers when they visit supermarkets or grocery stores (Australian Competition and Consumer Commission, 2008; Pemberton, 2008).

Questions 2, 3 and 4 were inter-related questions, designed to investigate the "Environmental Concern" and "Person Norm" of responders. In "Environmental Concern", the assumption is, again, that if customers frequently bring their own bags to a supermarket, he or she has more environmental concern than. Also, "How often did the responder bring their own bag" is the hypostatization for taking pro-environmental actions (Lam & Chen, 2006; Pemberton, 2008).

Furthermore, Questions 3, 4 and 14 investigated the 'Situational variables': here, if there was higher average loading of the bags held by the responder, it was assumed that he or she had a greater sense of environmental protection (Lam & Cheng, 2003).

Question 5 was designed to achieve the objective of 'Investigate substitutes for plastic carrier bags'; the options for this question included the most popular container which contains the goods held by responders. It has been shown that three common types of bag are used – the thick renewable plastic bag, the normal plastic bag and the non-woven/cotton renewable bag. An option for 'other' was presented as an open question (Environment Australia, 2002; Pemberton, 2008). A paper bag option was not explicitly included in this question, since these bags may be damaged by condensation of frozen products, and would be chosen by few customers.

Question 6 investigated the reason(s) why responders did not always bring their own bag(s) to the shops. This question investigated the behaviour intention factors which were 'Personal norm', 'Attitude toward behaviour' and 'Situational variables'. The options for this question were divided into two parts: the options '(iii) I recycled my plastic bags', '(iv) I threw out my plastic bags at home.' and '(v) I have used all my plastic bags for other things.' belong to the category 'Reuse', taken from a previous survey by Pemberton (2008); the remaining options belong to the 'Behaviours' of customers, the design of these options stemming from a range of previous surveys, as follows :

(i) I forget to bring them (Ching *et al*., 2010; Friend of the Earth, 2010; Research and Consulting Incorporated, 2011)
(ii) The bags will be provided by shops (Friends of the Earth, 2010; Research and Consulting Incorporated, 2011)
(vi) Bringing shopping bags to this supermarket is not convenient (Ching *et al*., 2010; Clean Up Australia, 2007; Friends of the Earth, 2010; Research and Consulting Incorporated, 2011)
(vii) When I take out a used bag it makes me feel embarrassed (Kubantova, 2011; Lam & Chen, 2006)
(viii) I had to buy more than I plan to use

Question 7 directly asked for opinions of charges for plastic bags, investigating 'Responder efficacy'. This examined customer perception, and level of citizen support which is necessary for a successful policy.

The acceptable price for responders needed to be established via Question 8. The ratio of levy and minimum wage was between 0.5 to 3 per cent in the countries that charged for plastic bags. Also of relevance is the commotion caused if prices are too high, requiring a levy being implemented without causing a change to the life quality of citizens (Democratic Party, 2007).

The behaviour change before and after the charge was tested by Question 9. The 'Environmental concern' and 'Self-efficacy' of responders would be assessed by this question (Lam, 1999; Lam & Cheng, 2003). It mainly focused on the group of responders which 'Sometimes' and 'Never' brought their bags to a supermarket. The efficacy of the charge could be predicted via this question.

For Question 9, the expected usage of money generated by a charge was investigated; the answers being potentially linked to the environmental concern of responders (ECOTEC Research and Consulting, 2001; Fullerton, Leicester & Smith, 2007; Killian, 2005). The options for this question were based on various countries which had charged for plastic bags.

(i) To add to their profits (Taiwan)
(ii) To reduce the price of goods (Canada)
(iii)As a foundation for environmental protection (Ireland; Department of the Environment, Community and Local Government, 2007)

'Personal norm' was investigated through Question 11. The HDPE consumption of plastic depends on volume, thickness and strength (Tough, 2007). If 'Stronger', 'Larger volume' and 'More long lasting' were preferred responses, then the total plastic consumption may increase after a charge is implemented, even though it may not be the original intention.

The age and gender collected via Question 12 and 13 were intended to aid further investigation if necessary.

Results of questionnaire and further analysis

Questionnaire data

Results of Question 1
The data from Question 1 (How often do you visit this branch of (Sainsbury's, M&S)?) are shown in Table 5.

Table 5: Data of Question 1

Frequency	Number of people (Sainsbury's)	Number of people (M&S)
More than once per week	41 (82%)	48 (96%)
Once per week	9 (18%)	2 (4%)
Once per fortnight	0 (0%)	0 (0%)
Less than once per fortnight	0 (0%)	0 (0%)
Sum	50 (100%)	50 (100%)

Description: There are 82% and 96% of customers who went to Sainsbury's and M&S more than once per week.

Result of Question 2
The data from Question 2 (Do you bring bag(s) to this supermarket?) are shown in Table 6.

Table 6: Data from question 2.

Frequency	Number of people (Sainsbury's)	Number of people (M&S)
Always	7 (14%)	21 (42%)
Frequently	14 (28%)	1 (2%)
Sometime	14 (28%)	6 (12%)
Never	15 (30%)	22 (44%)
Sum	50 (100%)	50 (100%)

Description: 42% of customers always brought their own bags and 44% of customers never brought their own bags to M&S, both of which are higher than Sainsbury's which is 14% and 30% respectively.

Result of Question 3
The data for Question 3 (How many bag(s) did you **USE** during this visit?) are shown in Figure 5.

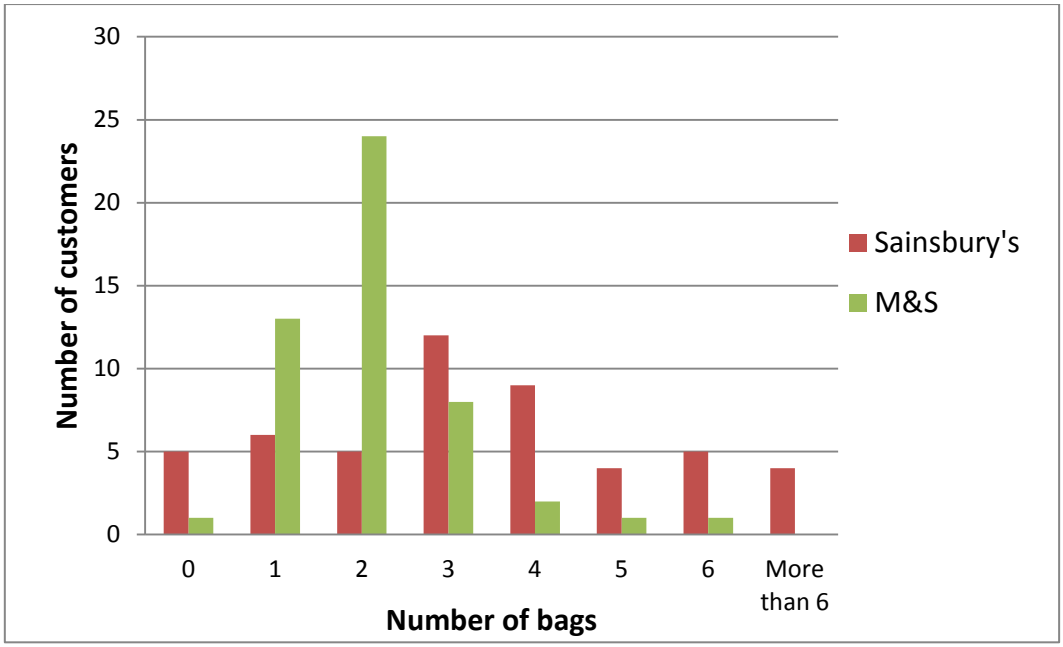

Figure 5: The number of bag(s) customers used during that visit (in both Sainsbury's and M&S).

Description: 68% of customers used more than three bags during that visit to Sainsbury's, the average bags used being (within 1 standard deviation) 3.32 ± 2.04. 64% of customers used 1 to 2 bags during that visit to M&S, the average bags used (within 1 standard deviation) being 2.08 ± 1.09. All responders who chose 'More than 6 bags' held 7 bags. The average bags used by M&S customers were lower than Sainsbury's customers. None of the responders used more than seven bags in the survey

.

Result of Question 4

The data for Question 4 (How many plastic bag(s) did you GET for this supermarket during this visit?) are shown in Figure 6.

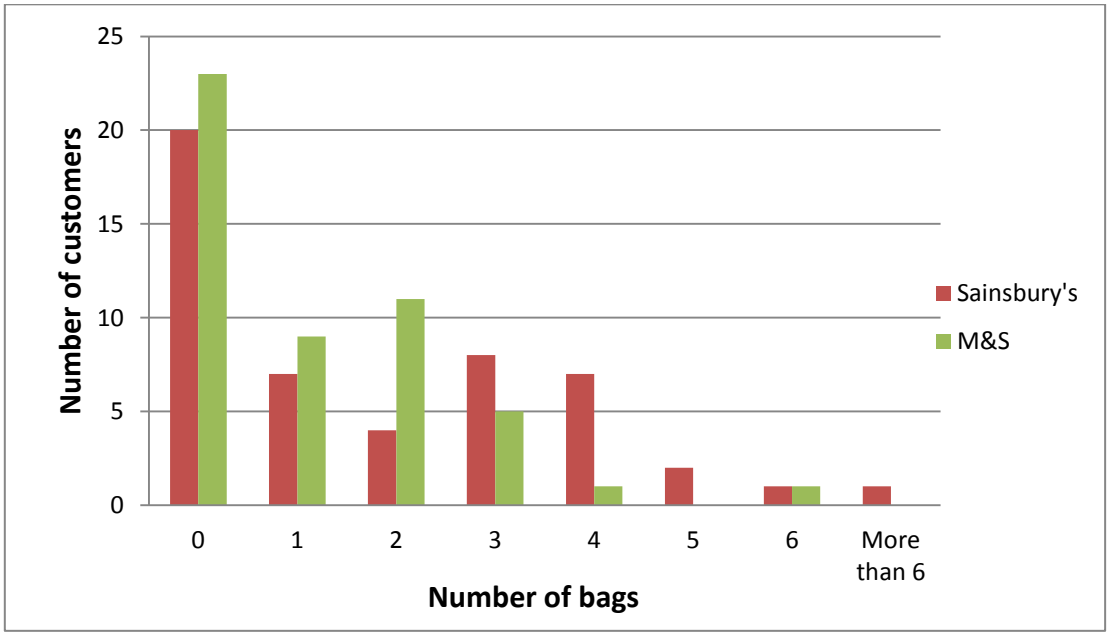

Figure 6: The number of bag(s) customers get during the visit (M&S).

Description: More than 40% customers did not get any bag from either supermarket.

Result of Question 5

The data from Question 5 (If you bring your own bag(s) to the supermarket, what type(s) are they?) are shown in Table 7.

Table 7: Data of Question 5

Types of bags	Count (Sainsbury's)	Count (M&S)
Thick renewable plastic bag	25	21
Normal plastic bag	0	0
Non-woven/ cotton renewable bag	16	11
Others	0	0

Description: Most of customers brought thick renewable plastic bags as their own bags, secondly were nonwoven or cotton renewable bag, no one choose normal plastic bags or other containers as their own bags.

Result of Question 6

The data from Question 6 (Why do you not always bring your own bags? (Can be more than one option)) are shown in Figure 7.

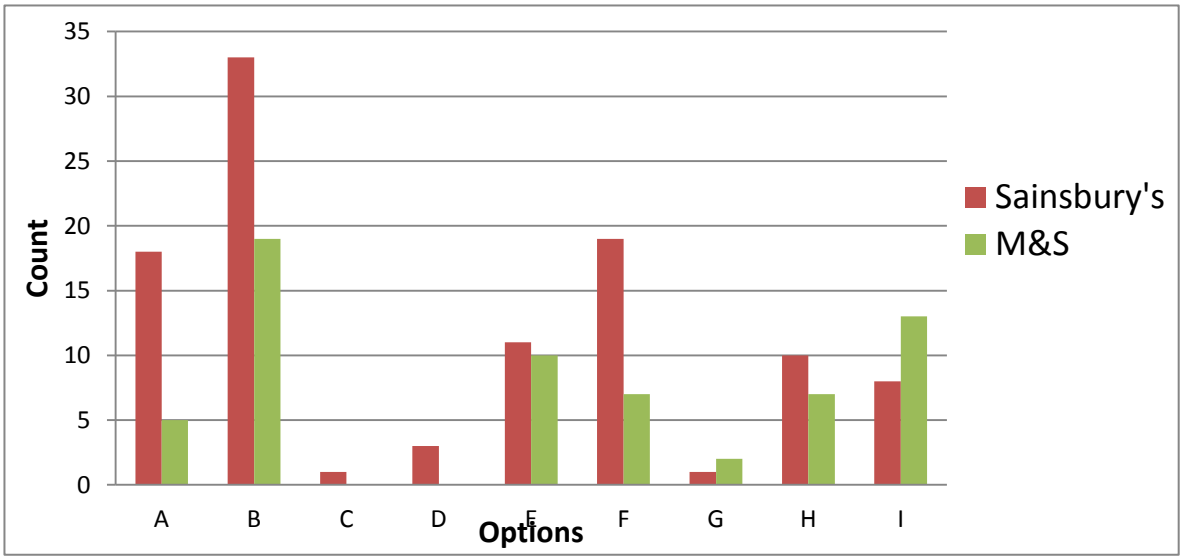

Figure 7: The reason(s) why customers did not bring their own bags (in both Sainsbury's and M&S), where the options were.

Option A	They forget to bring them
Option B	The bags will be provided by shops
Option C	The plastic bags bad been recycled
Option D	They threw out their plastic bags at home
Option E	All of plastic bags had used for other things
Option F	Bringing shopping bags to that supermarket is not convenient
Option G	When Customer took out a used bag it made them feel embarrassed
Option H	Customers had to buy more than they plan to
Option I	Others

Description: The major reasons why Sainsbury's customers did not always bring their own bags was "The bags will be provided by shops" and "Bringing shopping bags to that supermarket is not convenient".

In M&S, the major reason was 'The bags will be provided by shops' and 'Others', the 3 most frequent being:

1 The customers thought that the bags were goods, that they can buy them.
2 The customers thought that they bought environmentally friendly bags
3 The customers thought that the bags were environment friendly and they save the environment by buying them.

Result of Question 7
The data from Question 7 (Do you think it is a good idea to force all supermarkets to charge for plastic bags?) are shown in Table 8.

Table 8: Data of Question 7

Options	Number of people (Sainsbury's)	Number of people (M&S)
Yes	22 (44%)	38 (76%)
No	13 (26%)	3 (6%)
Don't know/ No idea	15 (30%)	9 (18%)
Sum	50 (100%)	50 (100%)

Result of Question 8
The data from Question 8 (If a plastic bags charge is introduced by supermarkets, what payment per bag would be acceptable for you?) are shown in Table 9.

Table 9: Data of Question 8

Options	Count (Sainsbury's)	Count (M&S)
5p	33 (66%)	45 (90%)
10p	10 (20%)	5 (10%)
15p	0 (0%)	0 (0%)
Others	7 (14%)	0 (0%)
Average	6.04	5.50
Sum	50 (100%)	50 (100%)

Description: More than 65% of customers thought that 5p per bag was an acceptable payment in both Sainsbury's and M&S.

Result of Question 9
The data from Question 9 (What action will you take, if the price of levy equals your choice at Q.8?) is shown in Table 10.

Table 10: Data of Question 9

Options	Count (Sainsbury's)	Count (M&S)
Customers will bring their own bags	29 (58%)	31 (62%)
Customers will buy the bags from the shops	21 (42%)	19 (38%)

Sum	50 (100%)	50 (100%)

Description: Nearly 60% of customers would bring their own bags and 40% of customers would buy the bags from the shops after a shopping bag charge was implemented.

Result of Question 10

The data from Question 10 (How should the supermarkets spend the extra income generated by the plastic charge?) are shown in Table 11.

Table 11: Data of Question 10

Options	Number of people (Sainsbury's)	Number of people (M&S)
To add to supermarket's profits	1 (2%)	1 (2%)
To reduce the price of goods	39 (78%)	17 (34%)
As a foundation for environmental protection	10 (20%)	31 (62%)
Others	0 (0%)	1 (2%)
Sum	50 (100%)	50 (100%)

Description: 78% of Sainsbury's customers thought that the supermarkets should reduce the price of goods and 20% of customers thought that the money should spent as a foundation for environmental protection generated by shopping bag charges.

In M&S, 34% of customers thought that the supermarkets should reduce the price of goods and 62% of customers thought that the money should spent as a foundation for environmental protection which could be generated by the shopping bag charge.

Result of Question 11

The data from Question11 (Would you have any expectation of plastic bags quality after the introduction of a charge?(Can be more than one option)) are shown in Table 12.

Table 12: Data of Question 11

Options	Count (Sainsbury's)	Count (M&S)
Stronger	25	2
Larger volume	27	1
More long lasting	16	1
More environmental friendly	13	23
No expectation	15	25

Description: The major expectations of plastic bag quality after the introduction of a charge among Sainsbury's customers was for stronger, larger volume and more long lasting bags. In M&S, the major option selected was for 'No expectation' and 'More environmental friendly'.

Result of Question 12

The data from Question11 (The age group of responders) are shown in Figure 8.

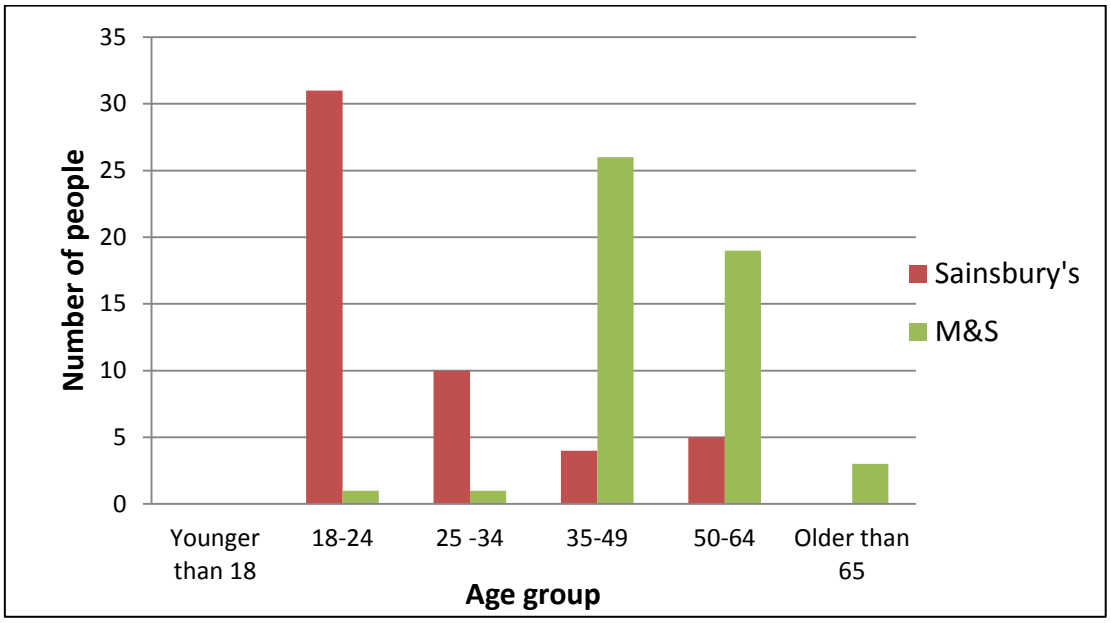

Figure 8: Age group of interviewers interviewed in both Sainsbury's and M&S

Description: 84% of Sainsbury's customers belonged to the age group of '18-24' and '25-34', while in M&S, 90% of customers belonged to the age group of '35-49' and '50-64'.

Result of Question 13
The data for gender of responders are shown in Table 13.

Table 13: Gender of interviewees

Gender	Number of people (Sainsbury's)	Number of people (M&S)
Male	24 (48%)	10 (20%)
Female	26 (52%)	40 (80%)
Sum	50 (100%)	50 (100%)

Description: Half of Sainsbury's interviewees were male and half female, whereas in M&S 80% of interviewees were female.

Result of Question 14
The average loading of bags which were held by responders were estimated by interviewers, this data showing in Figure 9.

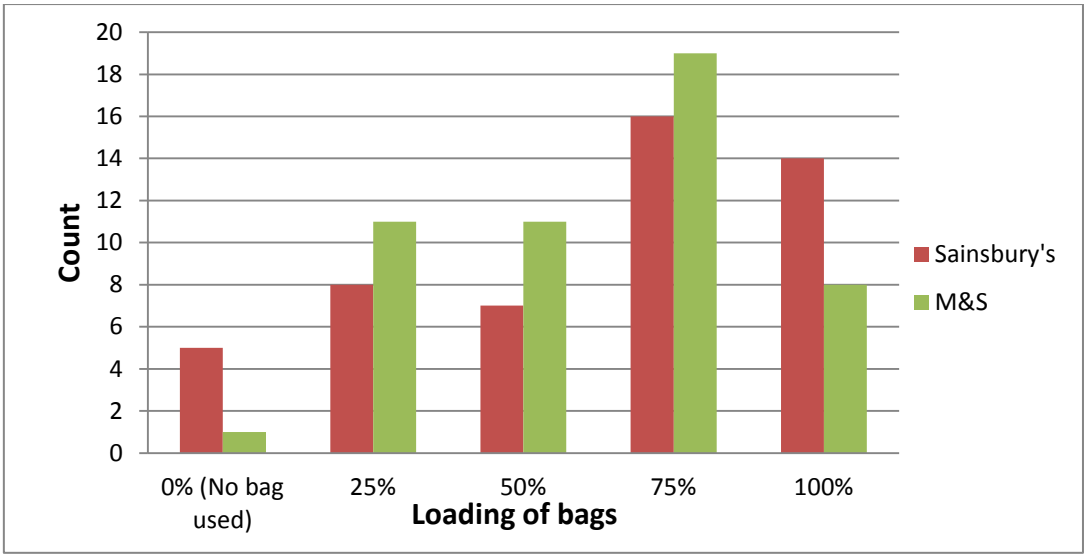

Figure 9: The average loading of the bags held by customers (in both Sainsbury's and M&S)

Further analysis

This section shows an analysis of correlations arising from the questionnaire data.

Correlation 1

The correlation between average loading of bags and number of bags picked up by responders was investigated: this mainly focused on whether the responders used a small number of bag(s) which meant 1 to 2 bags (Table 14).

Table 14: The loading of bag(s) if the customer using 1 to 2 bags during their visit

Loading of bag(s)	Number of people (Sainsbury's)	Number of people (M&S)
More than 50%	0 (0%)	11 (69%)
Less than or equal to 50%	7 (100%)	5 (31%)
Sum	7 (100%)	16 (100%)

Description: In Sainsbury's, where customers used 1 to 2 bags during their visit, their bags were emptier than the bags of M&S customers in the same condition.

Correlation 2

The correlation in frequency of customers bringing their own bags to Sainsbury's when more than 5 bags were used during the visit was investigated. This mainly focused on responders using more than 5 bags since they had used a larger amount of bags than the others (Table 15).

Table 15: The frequency of customers bringing their bags to Sainsbury's when more than 5 bags were used during the visit

Frequency	Number of people (Sainsbury's)
Always	7 (78%)
Frequently	2 (22%)
Sometimes	0 (0%)
Never	0 (0%)
Sum	9 (100%)

Description: 78% of customers always or frequently brought their own bags if large numbers of bags were used.

Correlation 3

This correlation is under two conditions, firstly the target group were Sainsbury's responders who always or frequently brought their own bags to Sainsbury's; secondly was that 5 or above bags were used during the visit. The correlation between these conditions and the types of bags reused was investigated (Table 16).

Table 16: The type of bags re-used where the customers always or frequently brought their own bags, and more than 4 bags were used during the visit

Types of bags	Number of people (Sainsbury's)
Thick renewable plastic bags	2 (20%)
Non-woven/ cotton renewable bags	8 (80%)
Sum	10 (100%)

Description: 100% of customers reused the non-woven/ cotton and thick renewable bags for their shopping, according to the above conditions. Two responders reused thick renewable plastic bags while 8 responders reused non-woven/ cotton renewable bags.

Correlation 4

The number of responders who sometimes or never brought bags versus a likely change in behaviour after implementation of a plastic bag levy was investigated (Table 17).

Table 17: The action customers who sometimes or never bring their own bags will take after a charge is implemented

	Action after charge implemented	
Frequency of customer bring their own bags	**Will bring their own bags**	**Will not bring their own bags**
Sometimes	11	9
Never	8	29

Sum	19	38

Description: 67% of these customers will still not bring their own bags if a charge was implemented.

Correlation 5
'Bringing bags to supermarkets is not convenient' is one of the major reasons for customers not always bringing their own bags. Therefore, the reason for this needed investigation. There were a significant number of Sainsbury's responders who had not brought their own bags for this reason and that 'The bags will be provided by the shop'. These data are shown in Table 18.

Table 18: The number of Sainsbury's customers who did not bring their own because bringing shopping bags was not convenient

	The bags will be provided by shops	**Others**	**Sum**
Count	16 (84%)	3 (16%)	19 (100%)

Description: 84% of customers that indicated that bringing shopping bags to Sainsbury's was not convenient had also stated the reason that bags will be provided by shops.

Discussion

The questionnaire successfully estimated and predicted the respondents' intentions to not bring their own bags to the supermarket and their corresponding environmental behaviour. The discussion that follows has been divided into: 'Plastic bag consumption', 'Environmental concern of customers', 'Behaviour intentions of customers' and 'The circumstances if plastic bag charging is implemented'.

Plastic bags consumption (Question 1,3,4,5 and 14)

Firstly, the total bag consumption depends on the frequency of customer visits and the number of bags given out per visit. Furthermore, the number of bags given out is based on the behaviour intentions of customers. There were overall 89 per cent of responders that went to the supermarket more frequently than once per week; shopping in supermarkets is an indispensable life for the UK citizens. Frequent visits is one of the reasons for increasing plastic bag consumption.

Secondly, 68 per cent of Sainsbury's customers used more than three bags during their visit; on the other hand, 64 per cent of customers used 1 to 2 bags during their visit to M&S. The average number of bags used by M&S customers was lower than Sainsbury's customers. The different consumptions of plastic bags between these two shops may not be the consequence of charging; it was associated with the size of supermarket and how many goods were provided by that supermarket which met the needs and desires of customers (Imlay, 2006). Furthermore, it was related to how many products were purchased by customers. The size of Sainsbury's is around two and a half times larger than the food hall at M&S where the interviews were located. Therefore, higher plastic bag consumption in Sainsbury's may have occurred due to customers buying more in that shop. Also, high carrier bag

consumption in M&S (had charged for it) may have occurred through a misunderstanding of the meaning of charging. This is further discussed below.

There were a total of 43 and 29 responders who did not always bring their own bags to the supermarket in Sainsbury's and M&S respectively. According to the result, just one responder did not always bring his own bags because he recycled them, and 23 responders overall (32 per cent of 72 responders) had used the bags for other purposes. That was much lower than the survey done by WRAP (2005) where 75.2 per cent of single use carrier bags were reused. This may be because the lifetime of Sainsbury's bags were much shorter, hence they are difficult to reuse. Also, non-woven or cotton bags were chosen by 27 responders (43 per cent in 63 responders) who had brought their own bags to supermarket in both Sainsbury's and M&S. The only use indicated for non-woven or cotton bags was as 'shopping bags'; customers cannot or find it difficult to reuse these for other purposes.

Last but not least, in Sainsbury's, there were 7 responders using 1 to 2 bags during their visit, with an average loading of bag(s) of under 50 per cent. This means that although it is easy to carry the purchased products without bags, but they still use them due to the convenience bags provide. Situational variables, such as goods being light, do not encourage the customers not to use bags (Lam & Cheng, 2003; Lam & Chen, 2006).

Environmental concern of customers (Questions 2,6 9 and 10)

The assumption in this questionnaire was that environmental concern was demonstrated by the frequency of customers who brought their own bags to shops - the more frequently a customer brings their own bags, the higher environmental concern is assumed (Chen & Yam, 1995; Gatersleben, Steg & Vlek, 2002; West, 2012). The degree in consumption of plastics is seriously affected by these groups of customers who 'Never' or 'Sometimes' brought their bags to the supermarket.

42 per cent of M&S customers 'Always' brought their own bags to the shop, that is a much higher result than Sainsbury's which was 14 per cent. This shows that the consumer behaviour for sustainable development could be modified by voluntary action by charging, a result that shows similarities to previous research (Ritch *et al.,* 2009). In that case, Ireland showed a significant reduction in plastic bag consumption as a result of charging. There is also convincing evidence that personal norms affect environmental behaviours (Stern, 2000). For example, as in six studies reviewed by Hines *et al*. (1986), people who owned a high responsibility for the environment were more likely to act in a pro-environment manner. In Lam and Cheng's (2003) study, environmental group members in Taiwan who perceived high personal norm were more likely to pay heed to environmental causes and to be ecotour interpreters that spread the protection for the environment message (Lam & Chen, 2006). Therefore, people bringing their own bags to shops indicate that their personal norms do affect their environmental behaviours.

Furthermore, 10 per cent of M&S customers (five people) said that the reason they 'Never' brought their bags to M&S was because the bags given are environmentally friendly bags; they thought M&S bags could 'Save' the environment. This group had a certain personal norm in environment, although they had misunderstood environmental bags and the purpose of charging.

For usage of money which is generated by charging, 78 per cent of Sainsbury's responders thought that the price of products should be reduced as a result; on the

other hand, 62 per cent of M&S responders thought that the money should be put toward an environmental conservation foundation. This meant that M&S customers were willing to pay more to save the environment, therefore M&S customers had more environmental concern that Sainsbury's customers.

Beside, 12 per cent of M&S customers (six people) thought that the plastic bag is goods with an implementable charge. If this group of people increased, the reduction targets for plastic bags would become more difficult to achieve.

In summary, M&S customers had a higher personal norm around environmental concern than Sainsbury's, although modified by charging, however the purposes of charging and environmental bags must be clarified.

Behaviour intentions of customers (Question 6)

The behaviour intentions of customers resulting in them not always bringing their bags to the supermarket were investigated by this questionnaire. The assumptions were that the Sainsbury's set-up was a current plastic bag consumption model, and the M&S set-up acted as a simulation after charging, which were defined by objective conditions based on the supermarket's policies respectively.

The major reasons for Sainsbury's responders 'not always bringing their own bags' were 'The bags will be provided by shops' and 'Not convenient'. 84 per cent of customers who chose 'Bringing bags is not convenient' also chose 'The bags will be provided by shops', therefore they think that is not convenient because bags were provided by shops.

The result showed that 36 and 10 responders forgot to bring their bags to Sainsbury's and M&S respectively. According to WRAP (2009), the biggest barrier to customers reusing their bags is that nearly half of those surveyed forgot to bring them back into store. This barrier was significantly reduced by a charge (shown as the result in M&S).

About the self-feeling, there were 3 responders that did not always bring their bags since they felt embarrassed when they took out used bags. The major reason related to this feeling was whether bringing a bag was convenient or not (Ching *et al*., 2010; Friends of the Earth, 2010; Research and Consulting Incorporated, 2011). Therefore, in order to achieve the target to reduce plastic bag consumption, a policy approach which makes the bringing back of bags convenient is needed.

In total, 17 customers did not bring their bags based on the fact that they had to buy more than they planned to; also the result shows that 78% of Sainsbury's customers ‘Always’ bring their own bags when more than 5 bags were used. This indicates that planned shopping contributes to a significant reduction of plastic bag consumption.

The circumstances of charging implementation (Q5, 7,8,9 and 11)

For the response-efficacy of implementing a plastic bag charge on all supermarkets, overall 56 per cent thought this is not a good idea or had no idea for this, meaning there is some uncertainty about bag charging. Further investigation is needed to discover the reasons behind these opinions.

76% of M&S customers thought that is a good idea to force all supermarkets to charge for plastic bags which is much more than Sainsbury’s at 44%. This indicates that as M&S had introduced the charging for a long time (charged since 2008), their customers may be much more acclimatised to charging than Sainsbury's.

The major target for plastic bag charge implementation is to reduce the plastic and bag consumption. Therefore the customers who sometimes or never bring their own bags are of most interest for this survey. These groups of customers were focused on for investigation of their behaviour and whether this would or would not change. The results showed that overall 67 per cent of these customers will still not bring their own bags if a charge is introduced, therefore the charge implementation may just change the minds of a small group of people.

There were a total of 78 per cent of responders that thought that 5 pence per bags was acceptable payment if a charge was implemented. The plastic bag levy introduced by the Irish government in 2002 charged 15 euro cents. The charge had increased to 22 and 44 euro cents in 2007 and 2009 respectively. Although the plastic bag consumption had slightly rebounded in subsequent years after charging, it was still 90% below the pre-levy level (Department of the Environment, Community and Local Government, 2007; HKEPD, 2007). It is suggested that economic factors are one of the reasons contributing to a change in customer behaviour; if government wanted to introduce an efficient policy, the charging should be enhanced appropriately (Convery *et al.*, 2006).

Also, the ratio of plastic bags given out by supermarkets per 100 bags was Sainsbury's at 62.7 per cent while M&S had 53.8 per cent. The plastic bag consumption had reduced 90 and 94 per cent in first year after charging was implemented in Hong Kong and Ireland respectively. According to Chapin (2011), the effectiveness of a policy depends on target population; the higher the population, the more difficult to achieve the policy target. The population of Hong Kong and Ireland was 7.1 and 4.6 million in 2011 respectively, which were much lower figures than the UK population (62 million) in 2011 (Nation Master, 2012). Therefore, if there are the same objective conditions between Hong Kong, Ireland and the UK, the reduction target should be reasonably reduced; so that 60 per cent reduction in consumption of plastic bags as defined as 'significant reduction' were estimated (Chapin, 2011). The result indicates that charging has a positive effect on the reduction of plastic bag consumption (8.9 per cent reduced) but not a significant one.

For the expectation of plastic bag quality after the introduction of the charging, there are significant differences between Sainsbury's and M&S. On one hand, the major expectation of plastic bags of Sainsbury’s customers is that they are stronger, larger volume and longer lasting. Also, 9 out of 10 responders would choose the non-woven or cotton bags as reused bags if they 'Always' or 'Frequently' brought their own bags when more than 4 bags were used during a visit. Since the increasing consumption of HDPE may be attributed to these requirements, for example just like the case in Taiwan (Lam & Chen, 2006). The strength of plastic bag depends on the content of HDPE, so for a stronger bag, more HDPE is required (Tough,2007). On the other hand, most customers thought that the quality of M&S bags were good enough, they want the bag to become more environmentally friendly, but they may not know what an environmental friendly plastic bag is, they may just trust the slogan, but at least they want to save the environment. The volume, strength, lifetime and environmental friendly factors of a plastic bag should be included in the criteria when considering the charging.

The major reused bags were thick renewable plastic bags and non-woven bags, in Sainsbury's when the customers reuse more bags, they tend to reuse non-woven bags. This style had especially shown up for Sainsbury's customers when more than 5 bags were reused during the visit. On the other hand, this phenomenon had not

shown in M&S; this is related to the quality of bags which are provided by the shops. The phenomenon can be proven by Question 11; Sainsbury's customer's tendency to reuse non-woven bags may be due to the lower strength of Sainsbury's bags. On the other hand, customers thought that the quality of M&S bags were good enough in terms of strength, volume and lifetime. The strength and thickness of plastic depends on percentage of HDPE (Tough, 2007). The thickness of Sainsbury's and M&S bags is 19 and 30 microns respectively (Buchanan, 2008; Smith, 2008; WRAP, 2011). There were 13 billion carrier bags given in the UK and 1.78 billion bags given out by Sainsbury's in 2007 respectively (Poulter, 2008), or in other words, 13.7 per cent of the UK plastic bag consumption is given out by Sainsbury's. Therefore, if Sainsbury's improved the thickness of bags as per M&S which is 30 microns, more than 59.9 per cent HDPE would be required for plastic bag production in that store.

Conclusions

In conclusion, customers' behaviour is induced by intention factors; these behaviours for sustainable development could be modified by voluntary action of plastic bag charging. Customers' behaviour was also related to their environmental concern and attitude. Even if charging on plastic bags is implemented, the reduction targets in plastic or bags may not be achieved in the short term if customers do not change their behaviours and no appropriate policies are applied. From an environmental conservation viewpoint, paper, non-woven and bio-degradable bags are not a good replacement for plastic bags since the same adverse environmental impacts will occur. Therefore, it is not the right time to introduce a plastic bag charge until the customers change their behaviours.

Recommendations

There are many plastic bag replacements such as paper and biodegradable bags that individuals or companies claim are environmentally friendly. This may induce the higher degree of adverse environmental impacts which were mentioned previously, for example, water pollution and global warming. The most environmental option is not to use bags anymore. If it is unavoidable to use bags, a positive alternative would be to reuse a non-woven bag more than 30 to 50 times.

There were some misunderstandings around environmental bags and the purpose of plastic bag charging. Therefore, the purposes of charging and meaning of environmental bags should be clarified by governmental policies or companies' advertisements. Education may be an effective policy especially in children to reduce plastic bag consumption. It is a long term investment and takes time to effect. Continued efforts to educate the public to change their behaviour for generation after generation is necessary (Kralevich, 2008).

For community responsibilities of companies, economic incentives can be introduced by stores. For example, Tesco has rewards for customers who reuse their bags, such as 'Green Club card Points', which launched in August 2006 and 3 billion bags had been saved by 2010 (Tesco 2010a; Tesco, 2010b).

For the amount of charge, most responders thought that 5 pence per bag was an acceptable charge. Therefore if plastic bag charging of 5 pence per bag was to be implemented, it may not be effective enough to have a deterrent effect or encourage the customer not to use a plastic bag. That is to say, to ensure an effective charging policy, the consumption of plastic bags and public concern should be investigated to consider a charge that is higher than 5 pence per bag (such as 10 pence per bag).

Some customers thought that bringing their own bags to a store was not convenient because they cannot put the reusable bags into their jacket pockets (Baird, 2010). The surface area of a plastic bag is highly decreased and can be easily put into the pocket of jacket

For the usage of money which is generated by charging, most responders thought that use for a foundation for environmental conservation and reduction in the price of goods would be appropriate. Even if the price of goods was reduced via that money, it would be impossible to reduce all the goods and difficult to determine which type of goods should be reduced. In other words, charging used as a foundation for environmental conservation programme would be more appropriate and fulfil the purposes of charging. Moreover, the government, retailer and the green organisations could work together to achieve this goal. The proposal for conservation planning programmes organised by each green organisation with an interest in this foundation could be submitted to the retailers and government. Governments could make public consultations so that the public can voice their comments on decisions on how proceeds from charges could be donated to which organizations. The final usage of charging should reach consensus between public, government and the retailers.

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